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iNFORMATiON SOCiETY: MODELiNG A COMPLEX SYSTEM WiTH SCARCE DATA

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Considering electronic implications in the Information Society (IS) as a complex system, complexity science tools are used to describe the processes that are seen to be taking place. The sometimes troublesome relationship between the information and communication new technologies and e-society gives rise to different problems, some of them being unexpected. Probably, the Digital Divide (DD) and the internet Governance (IG) are among the most conflctiive ones of internationally based e-Affairs. Admitting that solutions should be found for these problems, certain international policies are required. in this context, data gathering and subsequent analysis, as well as the construction of adequate physical models are extremely important in order to imagine different future scenarios and suggest some subsequent control. in the main text, mathematical modelization helps for visualizing how policies could e.g. influence the individual and collective behavior in an empirical social agent system. in order to show how this purpose could be achieved, two approaches, (i) the Ising model and (ii) a generalized Lotka-Volterra model are used for DD and IG considerations respectively. it can be concluded that the social modelization of the e-Information Society as a complex system provides insights about how DD can be reduced and how the a large number of weak members of the IS could influence the outcomes of the IG.

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I. INTRODUCTION

The intensive usage of the information and communication technologies (ICT) in daily life has given rise to the Information Society (IS) concept, as well as to different problems, some of them unexpected, for which it is clear that stable solutions should be found as soon as possible. Therefore certain policies are rapidly required. Neither their plan nor their regulation should be left to theoretical considerations only, but could be surely much focussed if some primary testing could be made before their implementation. Due to the global ICT interconnections, information is transmitted almost instantaneously. But different societies and cultures have different reactions to the information received and different times to absorb it. In order to reach a people centered, inclusive and development-oriented Information Society the World Summit on the Information Society proclaims (WSIS-03/GENEVA/DOC/4-E, 12 December 2003), policies to be applied should be carefully analyzed as they need to fill up at least two different issues: (a) to be acceptable for the national society, and (b) to be coherent with the external conditions.

The present study concerning the electronic aspect of the IS, here below so called e-Information Society (eIS), is aimed at contributing to the definition of the most adequate policies that are required to achieve a harmonious IS. This contribution is devoted to show how social, legal and ethical aspects of the IS can and should be analyzed using the modern concepts of complex systems, as the eIS has most of those systems properties, in the sense that societies and economies are interrelated in a nonlinear way and often self-organizing within some general constraints. For this reason the socioeconomic problems which are spread globally need solutions which should be adequate to each society. This is not a minor task: modelization to forecast future scenarios is necessary, as it is expected to give at least a preliminary idea about the consequences of proposed 'solutions', especially since the speed at which interactions takes

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place, on the e-markets or more generally through e-informations, in the presently globalized context is quasi infinite. Moreover due to the new ICT, the context operates world wide on line, thus not only at the intranational but also at the international level.

Two relevant problems regarding the eIS are treated in this contribution: (a) the Digital Divide (DD) and (b) internet Governance (IG), both to be further defined and briefly commented upon in Section 2. Up to now, these two problems have been mostly expressed only through the perception of policy makers and intuition of social scientists, - and there is little data to be analyzed.

- On one hand, measurements on DD demand, to begin with, a strict definition of the concept, and afterwards, both careful design of polls and clear specifications about what is to be measured. Unfortunately, the existing data is not fully reliable, as, e.g., the United Nations Agency for international Telecommunication Union (ITU) self-admits it:

  "The STAT Unit verifies and harmonizes data, carries out research, and collects missing values from government web sites and operators' annual reports, particularly for countries that do not reply to the questionnaire. Market research data are also used to cross-check and complement missing values" (ITU ICT Statistics Database).

- On the other hand, IG is an idea, proposed from a theoretical point of view that is suitable for the interests of corporations that disregard the role of states at the time of defining policies, especially about their regulation. in this context, data analysis followed by the construction of adequate physical models which are able to describe different future scenarios that can be further discussed, appear to be if not extremely relevant, very much rewarding.

The present starting point is the survey of the ongoing policies and proposals, such as those that can be considered to be the outcomes of the WSIS, for instance, the internet Governance Forum (IGF); see Sect. 2. One main aim is to give *a priori* probable future scenarios, to suggest more adequate instruments to avoid DD and to design policies for IG. in order to do so we have used two much worked upon models taken from statistical physics to investigate each case respectively in Sect. 3. For DD, we use Huang version of the Ising model (Huang 1967); for IG, a multiagent (a so called prey-predator approach) system (Lotka 1925; Volterra 1931) is considered.

II. THE INFORMATION SOCIETY

Beyond the concept of Information Society posed when *"... the OECD acknowledged that the economy of tomorrow will be, to a great extent, information economy and the society will become information society which means that information will account for a significant part of added value of most goods and services performed and information intensive actions will become distinctive of the households and the citizens"* (WSIS 1998), leaving aside the discussion about whether it is or should be named Knowledge Society, rather than Information Society, the fact remains that today this concept involves important social, legal and economic issues, many of them unexpected in the nineties. The more so nowadays due to the plethora of economic means, when a newly evolving eIS expands.

A. About policies

There is a lack of a consensus on the definition of public policy (Birkland 2001). The meaning here given to the word policy is a course of action or inaction chosen by public authorities to solve, in most cases, an interrelated set of problems, as summarized by *http : //psychology.wikia.com/wiki/Government_policy_making*.here below only considering such problems derived from the complex nature of the Information Society. One main question arises: can such problems be solved by means of policies for ICT or rather should policies be implemented for the Information Society *per se*? Considering that the Information Society will affect most aspects of our lives, European policies, e.g., range from the regulation of entire industrial sectors to the protection of each individual's privacy (European Commission 2010)[1]. In Latin America, current programs for IS are likely *to promote public policies for the advancement of development-oriented IS, by aligning policies on the use of ICT for development; to promote transparent and participatory interaction* (ECLAC)[2].

Whence, for different realities, the same need of policies occurs. Moreover, the complexity of the governance appears since such policies should be both adequate to each society, i.e. locally, beside being globally workable.

B. The Digital Divide (DD)

However one should not assume the world to be so uniformed. Among the problems regarding the IS, and probably the most conflICTive of them, is the problem that makes the world be divided into people who do have and people who do not have access to modern information technologies. This problem is called the Digital Divide (DD). As the examples below do show, the DD has no univocal meaning.

In Europe (EU), the problem is considered in terms of "Broadband Gap Policy", which is concerned with the geographical aspects of the digital divide among EU regions.

In the USA, the DD seems to be analyzed in terms of individual options: *a study published by the Pew internet & American Life Project has found that there is a growing digital divide across America. Whilst a reasonable number of Americans are embracing new technology and Web 2.0, a disturbing number are either not getting the message, or are choosing not to participate.* (Riley 2007)

For Latin America (LA), the relation digital divide/social coherence is considered relevant not only by social scientists, but also by international organizations such as CEPAL (Hopenhayn 2008). However, corporations restrictedly analyze the problem in terms of telecommunications infrastructure (OECD).

In Africa where for most people even making a telephone call is still a remote possibility, cellular phones and internet telephony are considered as if they were *taking on the Digital Divide*.

In short, given the reality of todays competitive socio-economic scenario, societies appear to be divided between those who are"in" (included) and "out of" (either excluded or not included) the e-IS. But, beyond the ideas of those that analyze the world as if it were all alike Europe (Derrida 1987; Foucault 1984), the DD involves the gap between the educated and uneducated, between economic classes, and the more and less industrially developed nations. The Dependency Theory has demonstrated that the cause of such a dual society is the lack of endogenous growing capability (Cardoso and Faletto 2001). From another theoretical position, it has also been proved that whereas the developed societies have endogenous growing capability, the underdeveloped ones lack it (Romer 1990). So, policies are required to bridge the gap, beside giving rules for the evolving "game".

C. The internet Governance Forum

From a theoretical viewpoint, it is unconceivable that the internet, being a global network, should be submitted *only* to the national state regulation of each connected country. Neither should it be submitted to the national state regulation of *one* given country. in fact, internet would be an ideal example of an institution that can only be ruled by international law; but it is not.

Neither scientific nor political significant efforts are being made in this direction. On one hand, the WSIS is committed to governance, - a term that corresponds to the so-called post-modern form of economic and political organizations. Recall that "Governance" has, at least, six different meanings: the minimal State, corporate governance, new public management, good governance, social-cybernetic systems and self-organized networks (Rhodes 2007). Most of these viewpoints focus on legitimating projects of neo-liberal inspiration (de Senarclens 1998). *Governance can be seen as the exercise of economic, political and administrative authority to manage a country's affairs at all levels. it comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences* (UNDP).

On the other hand, some authors maintain that the cyberspace shows a somehow feudal character that emerges from the hierarchical privatization of its government associated with the granting of internet domains (Yen 2002; Elkin-Koren and Salzberger 2004). That is why the internet's government, like that of a feudal society, is highly fragmented (Yen 2002).

In the Tunis phase of the WSIS, in November 2005, governments asked the UN Secretary-General to convene a Forum, with the mandate to discuss the main public policy issues related to internet Governance in order to foster the internet's sustainability, robustness, security, stability and development. (WSIS- 05/TUNIS/DOC/6(Rev.1)-E). The inaugural Meeting of the internet Governance Forum (IGF) took place in Athens, in November 2006; in November 2007, a Second Meeting took place in Rio de Janeiro.

The different criteria for listing the participants (see Provisional Lists) in such meetings prevent us from making an accurate comparison of both meetings, in terms of "cause" and "effects". Taking a binary polarity point of view as a first approximation, it can be deduced, however, that companies, trade associations and non profit organizations fully committed to the internet were, in both of these meetings, composing the majority among the Entities, - a wide group, while a somehow private sector category that seemed or was supposed to represent the civil society was the minority group. Notice that, such organizations can also be found among International Organizations, provided they have any kind of international activity, e.g. ISOC, italy being an example of this statement.

Leaving aside, therefore in the present considerations, the current discussion on state or non-state regulation (de Souza Santos and Rodriguez Garavito 2005), there is nevertheless no doubt that there must be some kind of regulation regarding the internet, and that such a task demands

the full involvement of governments, the private sector, civil society and international organizations (WSIS, Tunis Agenda, 2005, 2).

and

in addition, there is a need to consider the following other issues, which are relevant to ICT for development and which have not received adequate attention: Activities on ICT-related institutional reform and enhanced capacity on legal and regulatory framework (WSIS, Tunis Agenda, 23, j).

So be it. interestingly, the Chairman's Summary of the second meeting provides some good material to analyze the debate regarding the legal aspects involved. The document shows, among several appeals to self-regulation and soft law instruments, a consistent demand of state regulations. An ECLAC document (Newsletter N°4) informs us, however, that

Representatives of Brazil introduced a variety of proposals about how to reform the ICANN, restrICTing its function to that of a coordinating organization. There was an extensive discussion about the future of the ICANN and its relationship with the USA Department of Commerce, whereas Brazil recommended the creation of a new international agency, composed by representatives of the civil society, to rule the access.

The Chairman's Summary alludes to this debate, but alas records neither authors nor proposals.

Other points covered the relation of governments to ICANN and whether is was appropriate for the Government Advisory Committee (GAC) to have only an advisory role as opposed to fuller powers in terms of international public policy. While one panellist argued that the participation of governments in the GAC was one of ICANN's most important features, another put forth that the current model with GAC as part of ICANN was not a stable model.

D. State Actors

A vast literature has developed over the last few years that theorizes and empirically studies novel forms of governing the economy that rely on collaboration among non-state actors (firms, civil organizations, NGOs, unions, and so on) rather than on top-down state regulation. From this viewpoint, the solution lies neither in the state nor in the market, but rather in a third type of organizational form, i.e. collaborative networks, involving firms and secondary associations (de Souza Santos and Rodriguez Garavito 2005).

Let the following quote be emphasized:

The international management of the internet should be multilateral, transparent and democratic, with the full involvement of governments, the private sector, civil society and international organizations (WSIS, Tunis Agenda, 2005, 29).

This is merely one of several similar paragraphs that can be found in WSIS documents. Such seemingly horizontal and democratic statements hide the fact that, apart from state and market, only the elites or members of the middle-class with the economic and cultural capital shall be stakeholders in the IG (de Ortúzar *et al.* 2007).

III. MATHEMATICAL MODELIZATIONS OF THE INFORMATION SOCIETY

A mathematical modelization would help visualizing if policies could influence the behaviour of social agents or not. in order to attain this purpose we have chosen the Ising model and a multiagent, prey-predator-like, so called Lotka-Volterra model (Lotka 1925; Volterra 1931).

A. Ising model approach to Digital Divide

The Ising model is one of the pillars of statistical mechanics. When developed by analogy in sociophysics one considers that the world is composed of lattice sites on which are located agents (originally magnetic moments); they interact with others in their neighbourhood; each site (agent) can have two values i.e. +1/-1; for simplicity we will consider that the underlying site network is a square lattice. Here we use it as a neighbour behaviour model. As in the Ising original version, the present model is analyzed in terms of two parameters: the temperature of the system and the external field. The temperature is associated to the degree of interest or relevance concerning a given situation, in this case to be in or out of the IS, while the external field(s) represent(s) the applied policy(ies). For simplicity, here below, the temperature is supposed to be the same in all simulations. it is intended to examine how policies (the

external fields) are able to accelerate the arrival at a desired situation, i.e. in the present case to have more agents in than out the IS.

The lattice, which represents a given society, has 100 x 100 agents. The initial situation in each simulation is taken at random, between +1 or 1 for the initial agent values. The simulations have been made using the method developed by Caiafa and Proto (2006) here below for three different enforced policies. The evolution in time (arbitrary units/iterations) without an external field (H=0) is considered to be a situation without policies. An external field, e.g., H = 1, in arbitrary units, corresponds to a weak policy enforcement. A more adequate or stronger policy can be also considered, e.g. for an external field H = 2 in arbitrary units. it is possible to follow the evolution within the in and out agents as a function of time in the three cases. The images and plots of the evolution of number of agents with value +1/-1 is shown, in Figs. 3-7, indicating that the appliance of adequate policies drastically reduces the evolution time required for the society in order to arrive to a state with more in than out agents. Comparing the data on the figures shows that if an external field is not provided (H=0), a lower number of agents is found in; (ii) it takes around three times longer to reach the same evolution state when H goes from 0 to 2.

Taken as example an interacting agent society (Fig. 1) in which several agents are in, and others out, initially distributed at random in the society (Fig. 2), and leaving the system to evolve without any imposed policies, the in and out agents nucleate in order to form two well defined fields. At the end, considered the asymptotic limit, the population of both categories is more or less the same and appears to be bound to stay still if the simulation time is increased. This is a DD state (Fig. 3). Now, by means of applying certain policies, the analyzed society acquires more mobility (Fig. 5 and Fig. 7). The agents offer resistance against the policy, what is shown in the strong transitory with rises and drops (Fig. 6 and Fig. 8). Finally, some of them move slowly from out into in, but the final result of such movement, though faster for H=2, is not much different from H=1.

in practical words, it seems that the particular society under analysis has been provided with the required induction. in other words, the policies here adopted (H=2) have proved to be more adequate than the previously more simple one (H=1).

IV. RESULTS

A. Some results of actual policies

it is of interest to recall whether some virtual features as those found above have had some similarity in the real world. in fact, in 2006, in Sao Paulo 54% of the entrepreneurs had access to internet, but only 47% of their firms had at least a personal computer; their access was used for on line bank and governmental services and e mail in an 83% (Bede 2003). On the other hand, the Argentinean firms in GBA not only had the equipment in the assets -93%- but also access to internet -90%-, but made poor use of it -62procedures, 49% on line banking services and 80% e mail- (UNLP 2005). Why is it that Brazilian entrepreneurs did such an intense and dynamic use of ICTs, even outsourcing the access to internet? The answer might be in the policies the Brazilian government adopted. in Brazil the Information Society, e-government being a part of it, is a state policy (Wilson 2004), not one governments policy. Consequently, successive governments have developed a strong program based on early decisions aimed to discourage physical presence when on line procedures are possible. it seems that Brazilian policy makers have found the adequate external field policy- in order to accelerate the arrival at a desired situation -agents dynamic interaction using ICTs, even by means of someone elses equipment-.

B. Internet regulation as a multiagent system. Lotka-Volterra model

To give a more concrete exemplification of the discussion on state or non-state regulations, and particularly to enhance the importance of the participation of non-state actors, it is adequate to appeal to a simple semi-empirical modelization of the problem at hand. The model introduced by Lotka (1925) and Volterra (1931) is applied here below to take into account a weight for (or size of) for agents, going beyond the binary polarization hypothesis studied here above. Such an extension of the Lotka-Volterra model outside biology and anthropology has been used in related fields to the present study, like in order to model the competition between web sites (Maurer and Huberman 2003), in hung scenarios in sociology (Caiafa and Proto 2006). The set of N differential equations (Maurer and Huberman 2003) of the model is the following:

$$\frac{df_i}{dt} = \alpha_i f_i \left(\beta_i - f_i\right) - \sum_{i \neq j} \gamma \left(f_i, f_j\right) f_i f_j \qquad \text{for} \qquad i = 1, .., N \tag{1}$$

where $\frac{df_i}{dt}$ means the time derivative of f_i, and indexes i, j run from 1 to N. The f_i is the weight of the i agent opinion, at time t, such that it is taken from a normalized f_i distribution. in other words, if some agent has an increase in size, another or a group of others must have a corresponding decrease in size. The parameters of the model are: α_i, the growth rate of agent i, and β_i, the saturation value of the i-th agent. in order to introduce the effect of the size of the agents, one can redefine the growth rate parameter α_i, according to Economo *et al.* (2005) as:

$$\alpha_i = \left(\frac{a}{b_i}\right)^4 \tag{2}$$

where a is the selection pressure which is, for simplicity, hereby, taken to be equal for all the agents living in the same environment, here the whole Information Society, and b_i is a parameter which reflects the inverse of an agent competitiveness; for example, in organization theory, b_i is associated to the *cost to do something* (Porter 1980). in the present study, the competitiveness should be understood as the cost imposed to an agent ideas/interests in order to accept the imposed regulations on the Information Society. This modification of the growth makes it possible to take each agent 'size' into account as suggested by Economo *et al.* (2005).

in our modelization, we have introduced two kinds of agents:

- The well-established in the Information Society agents; let us call them Old (O); they are e.g. ICANN, i.e. the gatekeeper of the internet, software companies, internet providers and NGO involved in the development of communications and the internet. These agents presently lead the *de facto* management of the net. We call them stakeholder.
- The agents that are trying to find a seat in the Information Society Governance. These are civil society agents, like NGO, individuals, SME and the like. Can be also included in this category, several governments that still have no definite policy about ISWe call them New (N) or participant.

C. Simulation results

For the present work, in order to illustrate the analysis, we consider only ten agents, keeping a =1 equal for all agents which means that all agents, living in the Information Society, are equally supporting the selection pressure. This means that, ideally, all the agents have the same rights as regards to the policies for the sustainability of the Information Society. Whence only the agent competitiveness has to be varied in order to look at the evolution and to determine the long term weight, i.e. importance of its opinion f_i, of the i-agent. Also for simplicity we keep $\beta = 1$. The $\gamma_{i,j}$ values are fixed and all equal either to +1 or -1. The O agents are supposed to be in competition among their community, through their $\gamma_{i,j}$ =-1), taken to be the same in all simulations. in Figs. 9 to 12, the evolution of f_i is shown for the exemplary case where there are 40% O agents, each having a different $\beta_i = 0.10, 0.11, 0.12$ to 0.13 in presence of 60% N agents, each having a different b ranging from 0.41 to 0.46, thus differing by 0.01 steps (0.4, 0.41, 0.42, 0.45, 0.46). The initial condition on f_i for both, the O- and N- agents is equal to 0.1.

The simulations show that when N do not cooperate among themselves (Fig. 9), their weights remain always below all the Old's weight. Therefore their opinions remain irrelevant or do not count in face of the O's opinions. in such a scenario, governments, the private sector, civil society and international organizations, that are not well established actors in the Information Society yet, in other words, mere PARTiCiPANTS, do not have any chance that their demands be attended, as regards to the Information Society's regulation. Nevertheless, it was also found that, when N agents cooperate among themselves, the weight of the opinions of O and N get closer and closer to each other: there is even a possibility for the opinions of N to win (Fig. 12) when all of them are in a cooperation scheme.

In these figures, it is demonstrated that cooperation allows New agents to become more and more powerful.

D. Interpreting policies in the light of the model

Coming back to the internet Governance context, in the Chairman's Summary we read:

- *There was a clear convergence of views that governments had an important role to play in creating a solid regulatory framework and making sure that the rule of law was well established and respected.*

It can be asked: convergence of whose views? in view of the presented figures, it may be wondered also whether it is a convergence of views of individuals, of organizations or of contributors. One can also question in whose benefit has such a demand been posed?

As the simulation results show, there is a chance to achieve a scenario where, by means of cooperation among N agents, their demands are attended. There are many weak agents among the N, but there is also China, Brazil and some relevant independent NGO. From such a further developed scenario might emerge the rules for a widely comprehensive and satisfactory government of the internet. it might also set the basis for the legal and political frames of the Information Society.

V. CONCLUSION

Numerical simulations with the Ising model let us see that the appliance of adequate policies reduces drastically the time required for the society under analysis, to arrive at, almost, all in agents. if external field is not provided, a lower number of agents shall be found in, and it takes around three times greater evolution range. Thus we have learned that, in many situations countries, regions, social groups-, defined policies should be implemented in order to encourage people to move in the Information Society. Through the multiagent system, we arrive to the conclusion that to attain an active role in the Information Society, and therefore participate in policies decisions, the N agents should cooperate among themselves (see Figs. 10-12) We have even some indication of the order of magnitude of the number of necessarily cooperating N agents in order to overthrow the O opinion/attitude/ and how long it takes (see Figs. 10-12). in both cases simulation results lead to solutions which are clearly equivalent to the consequences that some social scientists have forecasted, in terms of theoretical explanation of phenomena that are actually comparable to those that are taking place within the Information Society. in summary, the social modelization of the Information Society as a complex system provides insights about how the Digital Divide can be reduced and how the huge majority of weak members of the IS would influence the outcomes of the IG and, in so doing, allow the internet Governance to be multilateral, transparent and democratic.

Bedê, Marco Aurelio. 2003, A informatizaçao nas MPEs paulistas, (Sąo Paulo: SEBRAE) .

Birkland, Thomas A.. 2001, An introduction to the Policy Process: Theories, Concepts, And Models of Public Policy Making (Armonk, NY: M.E. Sharpe), p.21.

Caiafa, Cesar F. and Araceli N. Proto, 2006, Dynamical emergence of contrarians in a 2-D Lotka Volterra lattice, *international Journal of Modern Physics C*, 17: 385-394

Cardoso, Fernando Henrique and Enzo Faletto. 2001, Dependencia y desarrollo en América Latina, Siglo XXi Editores Argentina/Mexico (1^aed.1969).

CEPAL, Programa Sociedad de la Información $http://www.cepal.org/SocInfo/$

CEPAL , Newsletter N°4 Sociedad de la Información. Temas destacados del Segundo Foro de Gobernanza de internet, Enero-Febrero, 2008, 8.

de Ortúzar, Maria G., Noemi Olivera and Araceli Proto. 2007, Justice and Law in/for the Information Society, Actas de CollECTeR Iberoamérica, Argentina, pp. 297-304.

Derrida, Jacques. 1987, La escritura y la diferencia (Barcelona: Anthropos).

de Senarclens, Pierre. 1998, Mondialisation, souveraineté et théories des relations internationales (Paris: Armand Colin).

de Sousa Santos, Boaventura and César A. Rodríguez-Garavito. 2005, Law, Politics and the Subaltern in Counter-Hegemonic Globalization, in Law and Globalization from Below: Toward a Cosmopolitan Legality', Cambridge Studies on Law and Society, (Cambridge,MA: Cambridge University Press).

ECLAC Programme for The Information Society

Economo, Evan P., Andrew J. Kerkhoff, and Brian J. Enquist. 2005, Allometric growth, life-history invariants and population energetics, *Ecology Letter* 8: 353-360.

Elkin-Koren, Niva and Eli M. Salzberger, 2004, Law and Economics and Cyberspace. The Effects of Cyberspace in the Economic Analysis of Law (Cheltenham, UK: Edward Elgar).

European Commission. 2007, Governance in the EU. A White Paper.

European Commission. 2008, 2010-Broadband Gap. Broadband gap policy.

European Commission. 2010. Information Society and Media. Strategy for an innovative and inclusive European Information Society

Foucault, Michel. 1984, What is Enlightenment? ("Qu'est-ce que les Lumières ?"), in Rabinow, Paul, Ed., The Foucault Reader, (New York: Pantheon Books), pp. 32-50.

Hopenhayn, Martin. 2008, Brecha Digital y Cohesión Social en América Latina Una ecuación que no cierra, Seminario sobre los Retos de la Brecha Digital en América Latina, Programa EUROsociAL, Santiago de Chile.

Huang, Kerson. 1967, Statistical Mechanics (New York: J. Wiley).

IGF internet Governance Forum. 2007, Chairman's Summary Second Meeting, Rio de Janeiro, see $http://www.intgovforum.orgcms/secondmeeting$ (Chairman Summary. FiNAL.16.11.2007.pdf)

IGF. 2006, Provisional List of Participants, $http://info.intgovforum.org/PL.php$

IGF. 2007, Provisional List of Participants, $http://info.intgovforum.org/PLP\_2IGF.php$

ITU ICT Statistics Database, $http://www.itu.int/ITU-D/ICTeye/Indicators/Indicators.aspx$

Lotka, Alfred J.. 1925, Elements of Physical Biology, (Baltimore: Williams & Wilkins).

Maurer, Sebastian M. and Bernardo A. Huberman. 2003, A Competitive Dynamics of Web Sites, *Journal of Economic Dynamics and Control* 27(11-12): 2195-2206.

Mutume, Gumisai. 2003, Africa takes on the digital divide; new information technologies change the lives of those in reach. *Africa Renewal* 17(3):

OECD. Latin American Economic Outlook, see
$http://www.oecd.org/department/0,3355,en\_2649\_33973\_1\_1\_1\_1\_1,00.html$

Porter, Michael. 1980, Competitive Strategy (New York:Free Press).

Rhodes, Rod A.W.. 2007, Understanding Governance: Ten Years On, *Organization Studies* 28(8): 1243-1264.

Riley, Duncan. 2007, America: The Growing Digital Divide, Tech Crunch,
$http://www.techcrunch.com/2007/05/06/america-the-growing-digital-divide/$

Romer, Paul M.. 1990, Endogenous Technological Change, *Journal of Political Economy* 98(5, pt.2): S71-S102

UNDP. 1997, Governance for sustainable human development. A UNDP policy document, New York, 1.2.

UNLP. 2005, Observatorio de Tecnologias de información: Estudios realizados con Pymes (oct./dic. 2004 y oct./dic. 2005)

Volterra, Vito. 1931, Leçons sur la Théorie Mathématique de la Lutte pour la Vie (Paris: Gauthier-Villars).

Wilson, Ernest James III. 2004, Strategic Restructuring in Brazil, in: The information Revolution and Developing Countries, (Cambridge, MA: MiT Press), pp. 119-172.

World Summit on the Information Society $http://www.ITU.int/WSIS/index.html$

Yen, Alfred Chueh-Chin. 2002, Western Frontier or Feudal Society? Metaphors and Perceptions of Cyberspace, *Berkeley Technology Law Journal* 17: 1207-1263.

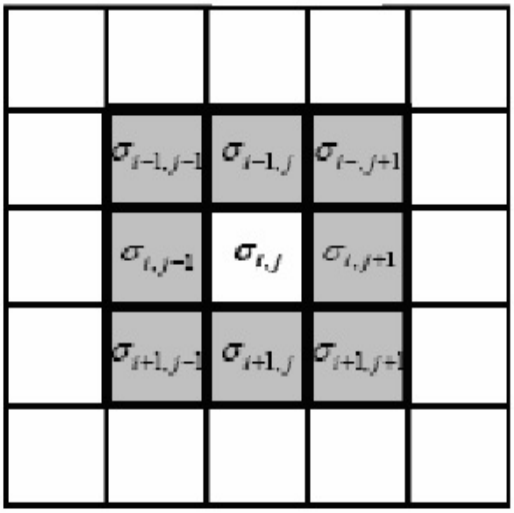

FIG. 1: Neighboring structure of an agent located at site i, j : each one has eight neighbors with whom to interact. Each agent is in a state σ depending on its location

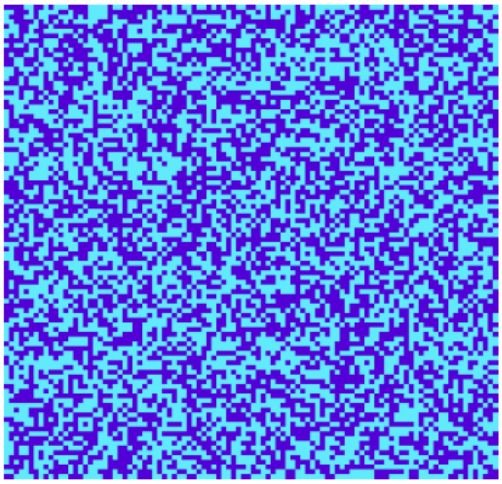

FIG. 2: Bidimensional plot showing initial situation of each agent. Blue dots are the in agents (+1) and cyan the out(-1) ones, as in the following draws.

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[1] $http://ec.europa.eu/information\_society/activities/broadband/policy/index\_en.htm$
[2] $http://www.eclac.org/socinfo/acerca/programa/default.asp?idioma = iN$

FIG. 3: Bidimensional plot showing the stable situation reached by each agent without an external field (without policies)

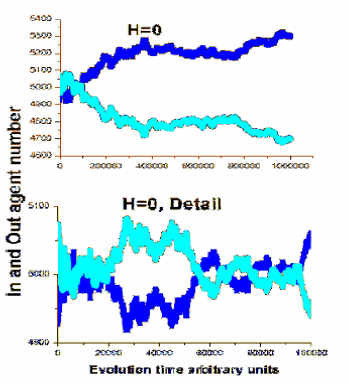

FIG. 4: The number of in and out agents, plotted versus time/iteration without an external field (without policies)

FIG. 5: Bidimensional plot showing the stable situation reached by each agent with an external field (H = 1, arbitrary units), i.e. some policy, is applied

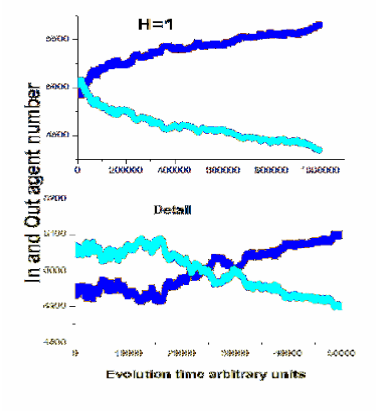

FIG. 6: The number of in and out agents, plotted versus time/iteration with an external field (H = 1, arbitrary units), i.e. some policy, is applied

FIG. 7: Bidimensional plot showing the stable situation reached by each agent when an external field (H = 2, arbitrary units), strong policy, is applied

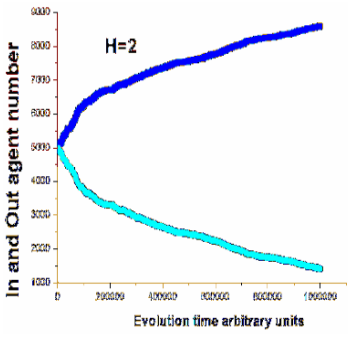

FIG. 8: The number of in and out agents, plotted versus time/iteration when an external field (H = 2, arbitrary units), strong policy, is applied

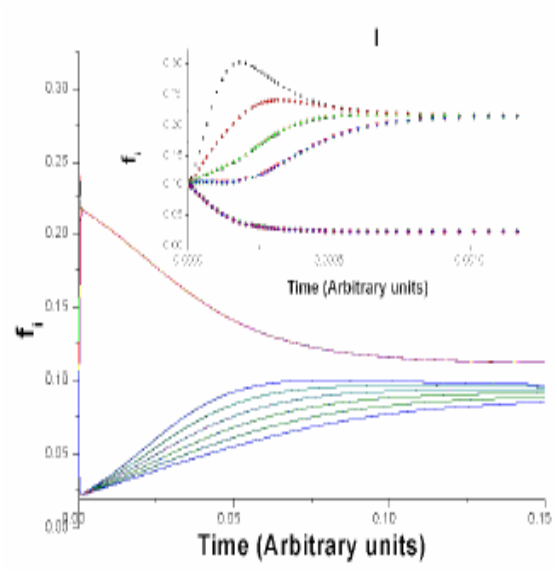

FIG. 9: New agents do not cooperate and Old agents compete among themselves. Blue line Old agents (superimposed behavior) I: Transitory regime. Violet line: New agents (superimposed behavior). Black, red, green and blue Old agents. As before, some curves are superimposed.

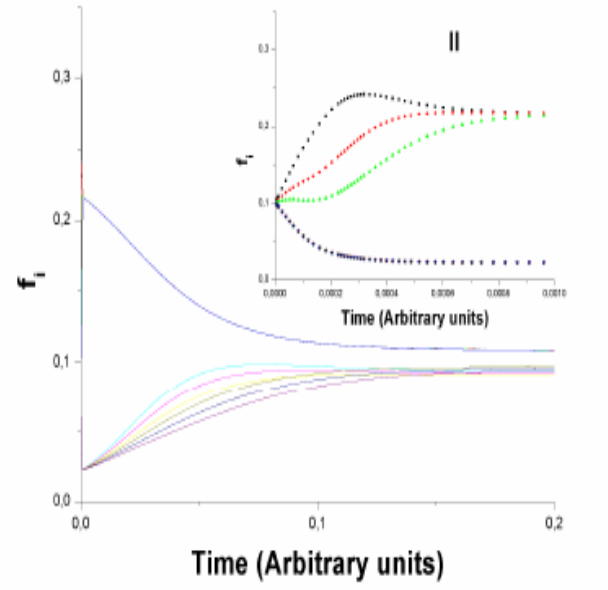

FIG. 10: Fifty per cent of the New agents cooperate and Old agents compete among themselves. II: Transitory regime, colors as in Fig. 9.

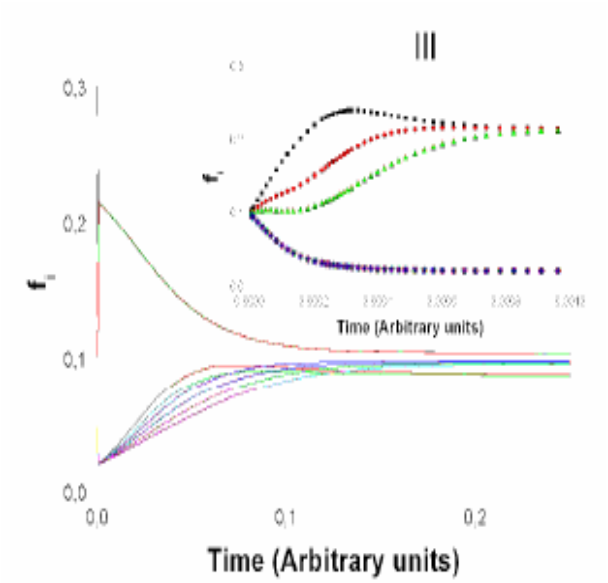

FIG. 11: Sixty six per cent of the New agents cooperate and Old agents compete among themselves. III: Transitory regime, colors as in Fig. 9.

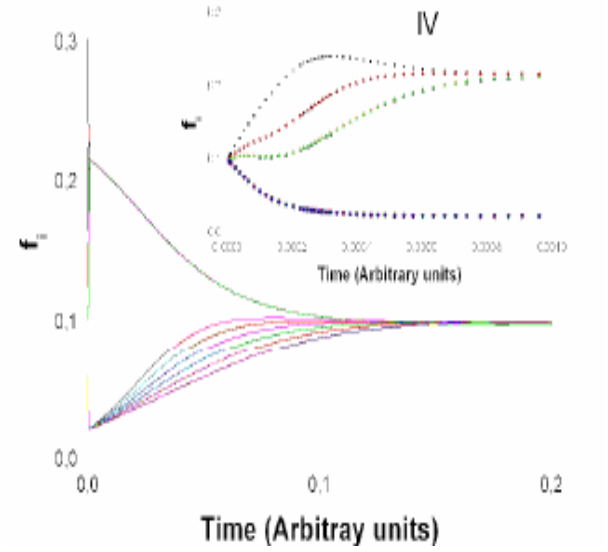

FIG. 12: One hundred per cent of the New agents cooperate and Old agents compete among themselves. IV: Transitory regime, colors as in Fig. 9.